U. S. DEPARTMENT OF COMMERCE

BUREAU OF FISHERIES

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STOCKING INTERIOR WATERS OF THE UNITED STATES[1]

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SPECIES DISTRIBUTED

Although the game fishes of interior waters provide less than percent of the Bureau's production of fish and eggs, the distribun of these forms constitutes one of the most important features of e work of the Bureau and receives the greater share of public tention. The stocking of inland waters is yearly becoming more nerally appreciated, and a desire to cooperate actively in this work s been manifested throughout the country by persons interested in hing as a business or for pleasure. Among the fishes most extenvely propagated for this purpose are brook, Loch Leven, rainbow,

[1] Material appearing in this publication is a revision and enlargement of Fishery Circular No. 8, originally prepared by E. C. Fearnow, Superintendent of Fish Distribution.

and black-spotted trouts, largemouth and smallmouth black bass rock bass, sunfish, crappie, and catfish. Various other species are handled to a limited extent.

SPECIES LIMITED IN ASSIGNMENT

SPINY-RAYED FISHES UNSUITED FOR TROUT AND SALMON WATERS

The Bureau adopted the policy some years ago of refusing all applications for black bass and allied species to stock waters of the Pacific States and Alaska now preeminent for their trout and salmon fisheries. This course was determined upon after a thorough canvass of the views of those most conversant with the situation and was endorsed by the officials of the States concerned. Although some waters of that section are not suited to trout or salmon, and already contain bass, the few instances that may be cited do not impair the force of the Bureau's contention for the exclusion of the species mentioned. There can be no denial of the fact that bass, sunfish, pike and similar predacious fishes are antagonistic to trout and young salmon, and only in exceptional cases will the Bureau consider shipping spiny-rayed fishes to waters of the Pacific drainage.

CARP CONSIDERED UNDESIRABLE BY MANY STATES

As carp are considered undesirable by many of the State fisheries authorities, the Bureau does not entertain applications for this species. A limited number are hatched in areas where there is a commercial carp fishery.

ORNAMENTAL FISHES NOT DISTRIBUTED

The Bureau has no appropriation for the propagation or distribution of ornamental fishes, and its only literature on goldfish, a publication entitled "Goldfish: Their Care in Small Aquaria and Ponds" (Fishery Circular No. 6), may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C., for 5 cents a copy. Ornamental fishes may be purchased from dealers in aquarium specialties.

RESCUE WORK

For many years the Bureau has been doing an important work of conservation by rescuing large numbers of native fishes from the temporary ponds and pools formed by the annual flooding of the upper Mississippi River and several of its tributaries. Over 90 percent of the fish so rescued are returned to the parent streams and less than 1 percent used for restocking depleted waters in the various States.

Due to the progressive canalization of the river, this work will be impracticable in the future and at this writing (1936) is being curtailed. Consequently, this source of supply of fish will be largely eliminated and all applications formerly filled from rescued fish will ultimately have to be supplied from hatchery output. The Bureau's ability, therefore, to make prompt deliveries of fish on application in the territory referred to is limited by conditions over which it has no control.

DANGERS FROM OVERSTOCKING

Overstocking is responsible in some instances for the small size
n attain. Applicants often request the introduction of new stock
correct this condition, whereas the remedy lies in reducing the
mber of fish to a point where the food supply will be sufficient to
rmit them to attain their maximum growth. By using in fish
lture the same judgment that is exercised in stock raising the size
fish may be considerably increased and much better results ob-
ned. A given area of ground will furnish forage for just so many
tle, and when more are added it means less food per capita. The
ne rule applies to fish, and no more should be placed in a body of
ter than the natural food supply will maintain. Young bass,
appie, and sunfish require natural food, and it is for this reason
at any surplus fish should be removed to other waters in which
supply of suitable food is available.

METHODS OF INCREASING THE FISH SUPPLY

Well-stocked streams and lakes add to the food supply of the
untry and also provide recreation for a large number of persons.
a recreation fishing is more generally engaged in than hunting,
ce the open season occurs during the vacation period. Good fish-
g often attracts attention to desirable sections that might other-
se be overlooked.

The supply of fish in a given body of water should be maintained
sofar as possible by the natural reproduction of the original
ck and its progeny. If, however, intensive fishing is carried on,
may be advisable to make additional plants of fish. There is
nger in introducing new species, especially the more voracious
ds, where desirable species are established. The competition for
od may result disastrously for the native species without giving
ything in return. The supply of fish in streams may be increased
o by the closing of small feeder branches that are suitable for
all fish and by the temporary closing of main streams in rotation.

SHORTAGE OF BASS

The Bureau receives approximately 15,000 applications for fish
nually, about 70 percent of which are for the so-called "warm-
ter" species, such as bass, crappie, and bluegills, the remaining 30
rcent being for various species of trout. While there is not much
ficulty in meeting the requests for trout (since they can be incu-
ted in troughs of running water and fed on artificial food until
y are large enough to be distributed), the situation with reference
the largemouth black bass, smallmouth black bass, crappie, and
egill is quite different, as these are nest builders and must be bred
der more or less natural conditions. Sudden changes in tempera-
e during the breeding season and other factors over which there
o control make the output of a station uncertain. Moreover, the
ny-rayed fishes, especially the basses, are predatory in their habits
d when confined in small water areas will devour their own
ng.

In spite of these handicaps, it is possible to produce 100,000 or mor advanced fry or ten thousand 3- and 4-inch fingerling bass to the acr of water if proper facilities are available. In this lack of pond acre age lies the cause of the inability of the Bureau to supply the quan tities of bass desired and needed. The principal requirement for th wholesale production of bass is space, even under intensive method of propagation, and the total area that the Bureau can devote to th propagation of these forms is less than 600 acres. There are hundred of thousands of acres to be stocked annually from the output of thes few ponds, and the ratio is obviously too unbalanced to permit th furnishing of anything but a nucleus for a breeding stock. Whil constant efforts are being made to increase the yield per unit area, th production of sufficient bass to meet the demand is plainly depender upon much greater hatchery facilities. One acre of pond space can not be made to supply enough fish adequately to stock a thousand o more acres of public waters subject to hard and constant fishing.

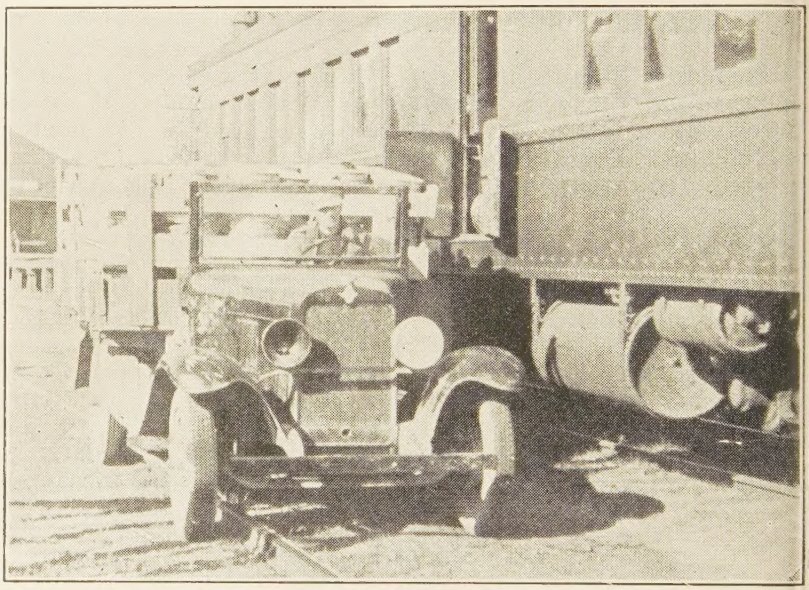

FIGURE 1.—Two methods of fish distribution—fish car and truck.

METHOD OF DISTRIBUTION

The Bureau operates four specially equipped cars in connectio with the distribution from its hatcheries located in the various State and these cars annually travel approximately 50,000 miles, stockin public waters in virtually every State in the Union. The distributio cars are of the Pullman type and travel in passenger trains. Man deliveries are made to applicants while the train makes its customar stops to receive and discharge passengers. These cars are equippe with both steam and electric air compressors for forcing air into th fish containers to renew the supply of oxygen in the water. The fis

e carried in insulated compartments. The new steel cars are uipped to carry from 250 to 325 regulation pails of fish. Most of e Bureau's hatcheries are now using automobile trucks to make de-

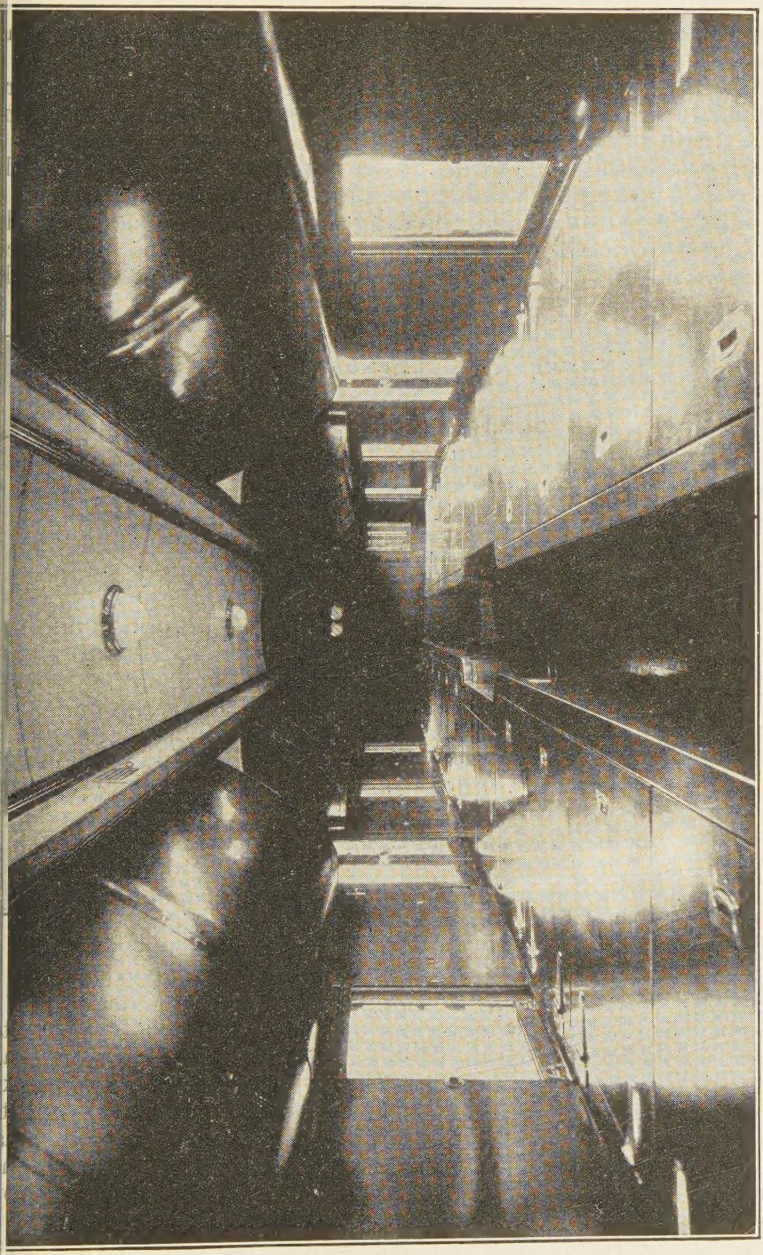

FIGURE 2.—Interior view of car no. 10, showing the fish-can compartments on either side of the aisle. The compartments have a capacity of 325 regulation pails of fish.

veries of fish. Each truck is fitted with racks, which enables it to rry a load of fish pails.

The Pennsylvania Fisheries Commission uses a fleet of automobile trucks to distribute fish. Each truck is equipped to carry 9 pails of fish, and the driver is accompanied by a helper. Yearling trout are successfully and economically transported to various parts of the State during the summer months. To maintain the proper temperature for trout, the sunken lids of the pails are filled with ice and tarpaulin covers drawn over them.

Several of the States are using tanks mounted on trucks for the transportation of fish. Such tanks are usually made of steel and supplied with removable splash boards. A transverse steel partition in the front of the tank forms an ice compartment. The truck is equipped for carrying 100 cubic feet capacity standard oxygen tanks in an upright position, and connections are provided so that any one of the tanks can be opened into a high-pressure pipe which leads to a regulator valve. The oxygen is liberated into the water through porous plugs or finely perforated pipes.

The fish are removed for planting through a 2½-inch valve and a hose of the same size. A truck of this type is in use at some of the Bureau's stations.

While the general construction of the various tanks used for the transportation of fish by truck is practically the same, there are methods of aerating the water other than by the use of compressed oxygen. In a number of instances compressed air is forced into the water under pressure, the power to operate the pump being obtained from the drive shaft of the truck or from a special motor. In this case the truck uses the same principle that is used on the Bureau's distribution cars.

Another method employed is the use of a centrifugal pump to circulate the water. The water is picked up from a screened intake at the bottom of the fish tank and is pumped under pressure to pipes above the tank. It is sprayed in fine jets, sometimes having been circulated through an ice compartment to cool it. Various modifications of this and other schemes have been developed experimentally.

The truck is a valuable adjunct to stations where large plants of a particular species are to be made, or in transferring large numbers of fish from one station to another. In the Bureau's general distribution it is often necessary to handle six or seven different species in one trip, and the practical method under such circumstances is to carry the fish in containers so that they will be available for delivery on short notice, since many of the Bureau's deliveries are made from its special cars and baggage cars while the trains make their customary stops to receive and discharge passengers.

Inasmuch as the Bureau's distribution schedule calls for occasional long hauls, frequently from the Mississippi River to the Atlantic seaboard, or farther, it cannot avail itself of truck transportation as fully as can many of the States that distribute their fish within a radius of two or three hundred miles.

The Bureau also cooperates closely with many of the States, sending its applications to be checked by the State authorities. Where the assignment of a species requested would conflict with the State stocking policy, the Bureau will not furnish the fish. In some instances Federal fish applications will be filled from State hatcheries or vice versa, where such an arrangement signifies economy.

In making distribution of fish, consideration is first given to the ıters from which fish or fish eggs were collected, after which ship- ents are then made to suitable public or private waters upon appli- tions previously submitted. Blanks on which formal requests for h may be made are furnished by the Bureau. These blanks call r a complete description of the waters to be stocked, and from this formation is determined the species of fish that is suitable and the mber that can be apportioned to the water area in question.

The Bureau finds it impracticable to investigate the condition of l streams to determine their suitability for particular species of h, although such a study would be highly desirable, as it would ford a basis for intelligent assignments. Since this is not practi- ble at present and the Bureau is required to rely on information rnished by applicants, it is decidedly important that such informa- on be as accurate and complete as possible.

FIGURE 3.—Automobile truck loaded with fish.

Applicants are notified immediately upon receipt of their requests ncerning the species assigned and the approximate date of delivery d are given full directions for receiving and caring for the fish. efore shipment is made a second notice is given, frequently by tele- am, stating an exact time for receiving the fish. Formerly fish ere delivered to the applicant's railroad station free of charge. ırtailment of funds and the need for devoting appropriations to oduction have forced a modification of this practice. While the ıreau delivers fish without cost in a few instances where special rcumstances require, the present policy is to require applicants to ceive the fish directly at the nearest hatchery, or to defray the costs the Bureau handles the shipment. The applicant must therefore prepared to assume the responsibility of accepting his allotment fish at whatever hatchery may be designated by the Bureau.

The Bureau frequently receives requests from applicants for the an of cans to transport fish from the station to the waters where ey are to be planted. Such request cannot be granted for the ason that failure to return loaned cans promptly disrupts distribu-

tion schedules and makes it impossible to move the hatchery output expeditiously. Many cans would be lost and experience has shown that the loaning of fish containers to applicants is impracticable. If no receptacles have been provided, the fish will not be delivered nor will they be delivered, even though receptacles are in readiness, unless the applicant or his representative is on hand to take care of them and sign the required receipt.

SIZE OF ALLOTMENTS

In making allotments on applications the following items are taken into consideration: (1) the area of water to be stocked as stated in the application, (2) size and number of fish available for distribution, and (3) distance the fish have to be transported. The Bureau does not attempt to furnish applicants with more than a sufficient number of fish for a brood stock for a given body of water, and it expects these to be protected and allowed to reproduce. The submission of an application form is not an "order" for a specified number of fish. On the contrary the applicant is merely sharing in the apportionment of a definite number of fish, which number cannot be increased to take care of an unexpectedly large demand. As a consequence, equitable treatment of all applicants may force restriction of assignments upon individual applications to quantities much less than are requested. Protests from dissatisfied applicants are given respectful attention; but, obviously, such protests cannot increase the total quantity of fish available.

SIZE OF FISH

In its distribution of fish the Bureau sends out certain species in the form of fingerlings or yearlings. This is especially true as regards brook and rainbow trouts. At certain stations, however, it is necessary to distribute a portion of the product before this stage is reached in order to prevent overcrowding. The basses, bream, and other pond fishes are distributed from 3 weeks to several months after they are hatched. The last lots of bass shipped usually range from 4 to 6 and the sunfish from 2 to 4 inches in length. The commercial species, such as whitefish, trout, cod, pike perch, etc., which are hatched in large numbers, are necessarily planted as fry. The basses, sunfishes, crappie, yellow perch, and other fishes rescued from the landlocked ponds and pools in the Mississippi Valley are from 3 to 6 inches in length when distributed. Eggs are distributed to State hatcheries and occasionally to applicants with the understanding that the resultant fry are to be planted in public waters.

PERIOD OF DISTRIBUTION

Because of the increased cost of shipping fish, trips to distant points are postponed until there are a sufficient number of applications to warrant the expense. The Bureau does not carry a stock of fish for delivery on demand, and when the supply of one year becomes exhausted it is necessary to wait until the next year's product is available to meet requests. The distribution of trout in the Eastern States is arranged early in March, and requests for trout

ubmitted after March 1 are carried over until the following year. n the Rocky Mountain regions trout are distributed during the eriod extending from May to October, and applications should be led with the bureau not later than May 1. Black bass, sunfish, appie, etc., are supplied from May to November, and requests for ose species should be filed prior to May 1, in order to receive atten- on before the following winter. It is the aim of the Bureau to fill pplications in the order of their receipt and to make delivery as on thereafter as possible.

AERATION OF WATER

When a large number of fish are confined in a receptacle, they on consume the oxygen dissolved in the water, especially if the essel is allowed to stand awhile. It is important, therefore, that pplicants receiving fish plant them as soon as possible. When the sh are carried in a vehicle, the splashing of the water serves to enew the supply of oxygen. This is true only when travel is over ough roads. Fish manifest their desire for oxygen by coming to he surface of the water. The water must be aerated, and a dipper hould be provided for this purpose. Sufficient aeration may be ccomplished by dipping the water and letting it fall from a height f about 2 feet, this process being repeated when the fish show signs f distress. Without expert knowledge in handling live fish, no ttempt should be made to hold them overnight.

A low temperature is an important factor in holding fish, as the ooler the water the more oxygen it holds in solution. The proper emperature may be maintained by wrapping the containers in wet acking or by placing ice in the cans.

A temperature of 60° F. for bass and 50° F. for trout is desirable, s at these temperatures the fish will not require much attention. t is a very difficult matter to keep water of a temperature of 0° F. aerated sufficiently to sustain more than a comparatively few iving fish.

PLANTING OF FISH

Before planting fish, the temperature of the water in the vessels hould be nearly the same as that of the water in which the fish are o be liberated. To equalize the temperature remove some of the vater from each vessel and replace it with water from the stream. The change should be gradual, at least one-half hour being con- umed to change the temperature 8°.

Young fish should be scattered in a small, spring-fed tributary hat is not frequented by large fish, in places where there is plenty f natural food and immunity from natural enemies. In ponds and akes, fish should be planted in shallow places where the water is ot stagnant (preferably near the water supply) and where there re water plants. The smaller the fish, the more care should be xercised in planting them. They should be distributed widely to ssure an ample food supply for them. If fish are planted in deep vaters, a few large bass or pike may devour them all; and even in hallow water, if not widely scattered, they may exhaust the food upply, after which the larger fish will prey on the smaller ones.

It is an excellent plan to study the waters to be stocked and determine the most suitable planting grounds before the arrival of the fish. When the consignment arrives, a large dipper should be used to aerate the water and to dole the fish out, a few at a place, where conditions are ideal for them. As a rule fish are very prolific, single individuals producing thousands of fry. By exercising care in making the plant and affording the fish proper protection, a few will multiply, if the conditions are favorable, and eventually the water will become well stocked.

COOPERATION WITH VARIOUS AGENCIES

UNITED STATES FOREST SERVICE

The major portion of fish distributed in the Rocky Mountain States is handled by forest rangers, who meet the consignments at railroad stations and carry the fish to the headwaters of streams. The method of keeping the headwaters of streams well stocked is productive of highly satisfactory results.

The Bureau has made surveys of thousands of miles of streams in the national forests and has drawn up a stocking program based on these surveys. Through an agreement with the Forest Service, this program is followed as closely as possible. Sometimes private applicants submit requests for fish for waters in national forests. These applications will be honored only if they are in accordance with the general policy approved for that section. Emphasis is being placed on the provision of good fishing as one of the recreational features of the national forests.

NATIONAL PARKS

Until within comparatively recent years the full possibilities of our national parks as fish preserves have not been given the serious consideration to which they are entitled. Realizing the necessity of maintaining a supply of fish in the waters of national parks, where fishing has become intensive during the open season, the Bureau has established stations in Yellowstone, Glacier, and Great Smoky Mountains National Parks. Skilled fish-culturists are assigned to make collections of and incubate the eggs of the various species of trout, the resultant fry and fingerlings being liberated in the waters most suitable for the particular species involved.

There is also a definite stocking policy in effect in the parks and the Bureau of Fisheries and the National Park Service cooperate closely in all measures which will assure better fishing to millions of park visitors.

RAILROADS

For a number of years the important railroads of the country have granted the Bureau the privilege of carrying in baggage cars in passenger trains shipments of fish when accompanied by attendants, the only requirements being that each attendant be provided with a first-class fare and the number of cans carried in a shipment be limited to 20. However, several railroads have volun-

ered free transportation for the Bureau's distribution cars when gaged in planting fish in waters contiguous to their lines.
The Northern Pacific, Oregon Short Line, Lehigh Valley, Pere arquette, Michigan Central, Chicago, Milwaukee & St. Paul, Chi-go & North Western, Chicago, Burlington & Quincy, Bangor & roostook, and the Maine Central are among the railroads that have tended courtesies in the way of free transportation or reduced rates the Bureau's cars or to messengers in charge of living fish.
This cooperation demonstrates the value that the railroad systems ace on the maintenance of well-stocked fishing waters in the regions rved by their lines. Such waters afford pleasure to the tourist d thereby increase traffic over the railroads, and they also have a ndency to make such regions more attractive to settlers.

FIGURE 4.—Distributing fish by pack horse to inaccessible waters in National Parks.

ORGANIZATIONS AND INDIVIDUALS

Without the excellent spirit of cooperation shown by organiza-ns and individuals and the valuable information received from glers' clubs and others interested in fishing, the Bureau, with its nited funds, could not undertake more than 75 percent of the ork it now accomplishes in interior waters. The expense of trans-rting fish from the hatcheries to the streams is no small item for e sportsmen to meet, but the newly imposed requirements for such operation have on the whole been met gladly.
Shipments of fish are sometimes met by 25 or 30 members of an ganization and the consignment divided among them and planted the waters most suitable for the particular species involved. metimes a number of applicants "club" together and designate e of their number to obtain their assignment, thereby reducing e individual cost. These organizations are also of inestimable lue in promoting sentiment for the enforcement of fisheries reg-

ulations and possibly serve to increase the supply of fish in streams by this means more than by making plants of fish. The Bureau desires to encourage the formation of such societies as will foster the supply of fish, and it is willing to render any advice that may be needed to attain that end. Applications for fish will be furnished such organizations when it is shown that the waters are in need of restocking.

A most practical means whereby organizations can cooperate with the Bureau is the establishment of fish nurseries or rearing pools. In this way the cooperating agency furnishes facilities (generally troughs or pools) for holding the fish for a period of several months

FIGURE 5. Equalizing the temperature of the water in the pail with that of the stream before planting the fish.

or a year. The Bureau supplies a stock of fish (usually advanced fry or small fingerlings), and the sponsors of the nursery feed and care for them until they have attained sufficient size to enable them to care for themselves when transferred to open waters. The Bureau supervises the selection of sites and construction of nurseries and furnishes such advice concerning the conduct of operations as may be required.

The Bureau further requires that 50 percent of the output of such a nursery be reserved for filling its own applications from that vicinity. While such projects are largely devoted to the rearing of trout, the same plan, with necessary modifications, may be adapted to pond fish such as bass if the proper natural conditions are present. While this plan throws some burden upon the sportsmen, it gives them what they have been demanding, namely, more fish of larger size.

STATE COOPERATION

There has been perfected an organization known as the National Planning Council composed of State fish and game authorities. The purpose of this agency is to coordinate State and Federal activities concerned with the conservation of fish life. The develop-

ent of stocking policies and the distribution of fish from State
d Federal hatcheries has been one of the most fruitful fields for
ch coordination. Consequently, in a number of States a Federal
h application will first be passed upon by the State authorities
d, if approved, may possibly be filled from a State hatchery or
livery may be made by State employees, the fish coming from a
deral hatchery. A full statement of all details of such coopera-
on would be too extensive for this publication.

FISH PROTECTION

After the fish are planted, the work of conservation begins. No
gency can successfully maintain good fishing in a body of water
here unrestricted fishing is permitted. If a sufficient number of
eeders are retained in a body of water, the supply of fish will
maintained through natural reproduction, provided the condition
the water is favorable for the species. Young fish should not be
ught until they have reached a size at which they will have
pawned at least once, and, as some fishermen take more than their
are, a bag limit is essential. In the case of waters that are fished
avily, even size and bag limits and no fishing allowed during
e spawning season will not suffice. In such waters, fish refuges
ould be set aside to guarantee an ample supply of brood fish.
he fish refuge should be a section of a stream or a portion of a
ke selected because its environment is favorable to fish propaga-
on. It is believed that the average person would respect such
aring grounds when he understood that it was for his own benefit
d that he still had the privilege of fishing on an open portion
f the stream. Such a plan would put fish conservation on a
ractical basis.

RESTRICTIVE FISHING LAWS ESSENTIAL

It is obvious to everyone giving thought to the subject that un-
stricted fishing, particularly in inland waters, can have but one
sult, namely, the complete disappearance of desirable fish. It
hardly probable that the most highly developed methods of arti-
cial propagation, however intensively applied, can be made effec-
ve against the rapid growth of the country and the increasing
umbers of anglers unless such work is supplemented by natural
production. This implies restrictive laws on fishing and the de-
elopment of a public sentiment in favor of such laws and their
nforcement. The following suggestions embody a few of the more
nportant points for consideration in connection with fish protec-
on. It is hardly possible to frame laws that can be applied gen-
ally. Each section of the country will find it necessary to modify
e laws to meet existing local conditions. However, uniformity is
esirable where practicable.

As an earnest of good faith on his part—that he respects the
shing laws and intends to observe them—the prospective fisherman
efore starting on his trip should obtain from the State fisheries
uthorities a license to fish. If we are to protect any species of
nimals protection must be extended to the young. Therefore,
size limit on the fish that may be legally taken is unquestionably

essential. If natural reproduction is to reach its highest valu fish must not be molested during their mating season. The tru sportsman on his fishing trip is not seeking a large number of fis but rather recreation in the open, and it is unsportsmanlike t take more fish at one time than can be properly used. This ide suggests the desirability of limiting the number of fish that ma be legally taken in any one day. Angling is recognized as one c the most popular sports, but it is not sportsmanlike to take fish b other than sportsmanlike methods, which usually implies a rod an line held in the hand. The use of poisons or explosives and the shoot ing of fish are always reprehensible. The wanton obstruction of th free passage of fish in any stream, the deposit therein of trade or othe

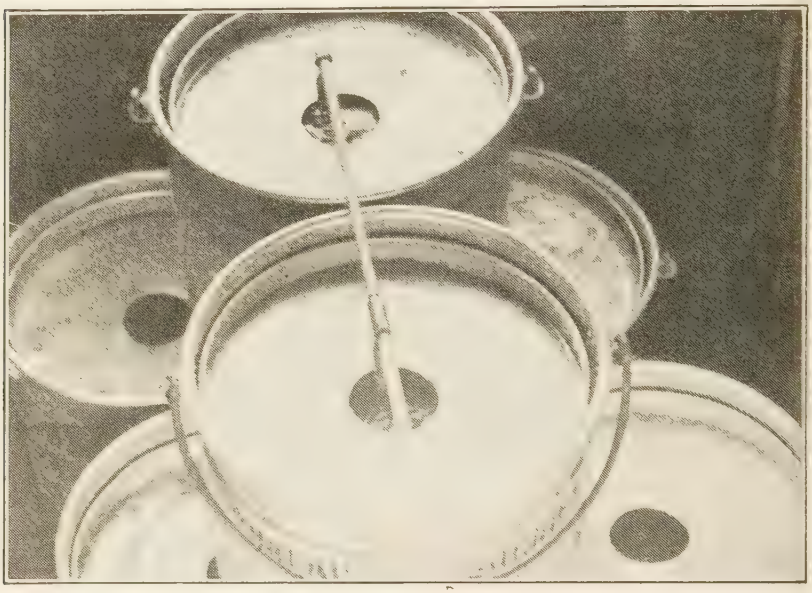

FIGURE 6.—Bureau of Fisheries standard fish distribution pails with aerators.

wastes injurious to fish, the operation of irrigation ditches withou screening them for the exclusion of fish, all of these practices are pro lific causes of unnecessary depletion of fish life in inland waters. I streams across which dams have been erected for industrial pur poses fish will frequently congregate in considerable numbers a certain seasons of the year. To take them from such places b spearing, gaffing, or other means is obviously not sport but wanto destruction.

ENFORCEMENT OF FISHERIES LAWS

The Bureau has no jurisdiction in the enforcement of fisherie regulations excepting in Alaska and in respect to the sponge fisher ies beyond State limits in the Gulf of Mexico, and the Federal lav regulating interstate transportation of black bass, such matters com ing under the State governments. If the fish and game laws ar not enforced, the matter should be taken up with the proper official

the State in which the violations occur. The Bureau will not nowingly furnish fish for waters in which illegal fishing is unecked. The matter of stream pollution and that of providing lequate fishways should also be taken up with the State fisheries ıthorities.

PREDATORS

Nature herself is responsible for an untold loss of fish of all vaeties through the ravages of predatory animals. These predators clude the mink, raccoon, frogs, snakes, cranes, herons, fish-hawks, sh-eating ducks, kingfishers, turtles, and other undesirable fish. he destruction effected by these enemies varies with their relative ɔundance in different sections. However, it is probable that snakes, ırtles, frogs, and predacious fish account for the greatest toll, since ıey all have the same aquatic habitat. Certainly there can be no ɔjection to a campaign for the destruction of these forms, whereas any of the other predators, particularly the birds, are protected by w. As to control methods, many individual ideas are in conflict

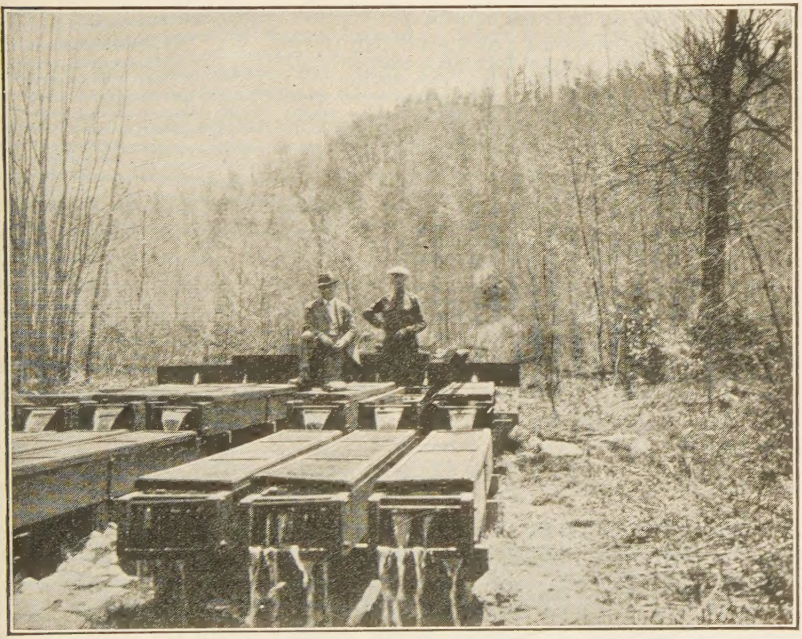

FIGURE 7.—Rearing troughs for trout at a cooperative station.

to the most efficient practices. A liberal use of firearms and clubs ems to be most effective with snakes. Traps built on the principle the minnow trap are sometimes used. Frogs can be speared, ıot, or caught in dip-nets, and the destruction of the egg masses in ıe spring will be useful in keeping down their number.

The most effective way of removing turtles from a pond or lake to draw off the water and collect them in hand nets. If this is not racticable, a pole about the size of a telegraph pole may be placed

slantwise in the water, at a point where the depth is from 4 to 6 feet, in such a position that its upper end projects about a foot above the surface. Stretch a net around the pole on all sides, except the one where the turtles would be most likely to crawl out of the water, adjusting it to form a pocket under the slanting end of the pole and fastening it with four or five stakes driven into the mud. A sudden approach in a boat will cause the turtles to drop off into the net, when they can be easily captured. Traps having a counter-weighted lid so balanced that the turtles will be dropped into a box or barrel when they crawl out to sun themselves are also used. Turtles, however, with the exception of the snapping turtle and soft-shell turtles are not considered very destructive of fish life. The latter can easily be captured by hook and line baited with a piece of fish and secreted in the weeds where the fish can not find it.

It is generally conceded that coarse fish, such as gar, pike, fresh-water dogfish or bowfin, carp, possibly suckers, and other forms of limited distribution are detrimental to game fish. There is no sure, quick, and easy method for eliminating these forms once they have become established, however. They are comparable to those animals classed as vermin which prey upon game animals and which have been the object of intensive campaigns for extermination for many years. Probably the best plan for controlling the numbers of undesirable fish is by intensive and persistent seining. The use of chemicals or explosives is more dangerous to the game fish than it is to the hardy forms and should not be considered. Where it is not possible to drain a body of water and remove those forms deemed undesirable, there appears to be no alternative except to utilize the various forms of gear employed in commercial fisheries. Close supervision should be maintained by fisheries authorities, however, to assure that no game fish will be destroyed. Selection of the particular forms of gear to be used, which may include haul seines, gill nets, trammel nets, fyke nets, or other forms of trap nets, is contingent upon the size and species of fish to be taken and the conditions under which the operations are to be carried on. It is generally impossible to eradicate undesired forms by heavily stocking with game fish.

AQUATIC PLANTS

A moderate amount of aquatic vegetation (sometimes termed "moss"), generally signifies favorable conditions for fish, especially in pond or lakes. It may become exceedingly abundant, however, and there are frequent inquiries as to how such growth can be destroyed. Chemical treatment using copper sulphate (blue stone) or sodium arsenite, will kill off current growth but will not prevent reappearance of the plants. Moreover, an overdose of these chemicals will kill fish as well as all fish food organisms, and the Bureau does not recommend indiscriminate dosage of fish ponds for the purpose of eradicating plants. As a rule, fish are not at all harmed by profuse vegetation, and while the angler may be inconvenienced, careless use of these poisons may do more harm than good. Unless a body of water is primarily used for boating or bathing and is rendered useless for these purposes by excess plant life, the destruction of the plants is generally unjustified.

POLLUTION OF STREAMS

The following information on the pollution of streams, adapted rom the report of the New York Conservation Commission for 1922, ill enable those interested in stocking public waters to decide hether the streams in which they are interested are polluted to ne extent that fish could not survive therein:

Pollution of a stream by sewage and other organic wastes may njure fish by removal of gaseous oxygen dissolved in water. This issolved oxygen is as necessary to fish as is oxygen of the air to he ordinary air-breathing animal; without it the fish suffocate.

Certain common and easily recognized water plants and animals how the dissolved oxygen status of the water and can be considered s indicators of the degree of pollution of a stream.

Water in a state of chemical purity does not exist in nature. Wa- er flowing in any stream carries in solution certain salts, gases, and ther compounds and frequently various matter in suspension. Only y the presence of these materials can aquatic life exist.

Pollution may actually kill fish at some stages of development nd not at others. It may be harmful to some species and not to thers, and it may have effects in any degree of gravity. It may ffect a small area of many miles in the length of a stream. In- ensity of pollution, extent of the affected area, and the habits of he fish normal to the stream must all be considered.

Failure to catch fish does not prove that a condition of serious ollution exists. Absence, real or apparent, may be explained by verfishing, failure to take the hook, or the fish may have gone lsewhere on their own affairs and not because of pollution. The mall plants and animals present, which either cannot move at all r cannot move far, show the average stream condition better than o the fish.

Plants growing in clean water are markedly green and frequently f more highly organized types than those in polluted sections, and nimal life tends to be more active and highly organized. Typical orm of animals and plants that will not inhabit polluted waters are hown in the following list:

Dobson or "Hellgramite" (*Corydalis cornuta*, Linn.). Larva. Three to four inches long. Under or around stones in swift water.

Stonefly (*Perla sp.*). Nymph. Under and around stones in swift water; very flat body with two "tails."

Caddis worm (*Hydropsyche sp.*). Larva of the caddis fly. Several species with various habits and forms; in swift waters mostly; under stones in loosely constructed pebble and webbing cases; attached to stones on the lee side of the current in compact stone cases, or in a funnel-like strainer of webbing with a retreat.

Mayfly (*Heptogenia sp.*). Nymph. Under stones in swift water; very flat body, smaller usually than stonefly; three "tails."

Dragonfly (*Anax junius*, Dru.). Nymph. Extensible "lower jaw"; darts forward by expelling water from behind; found in dense growth of green aquatic plants in still water. Damselfly nymphs are similar, but have three long, featherlike "tails."

Water penny (*Psephenus lecontii*, Lec.). Larva of a beetle. Common in swift water, clinging closely to underside of stones, occasionally at top or sides.

Fresh-water shrimp or "scud" (*Hyalella sp.*). Weedy portions of the stream; rapid swimmers; tail foremost.

Water net (*Hydrodictyon reticulatum* (*L*) *Lagerh.*). A green alga of the pond areas of streams. When spread, it resembles a fine meshed veil; a remarkable oxygenator.

Water moss (*Hypnum riparium*). Attached to stones or gravel in swift streams.

Some species of plants and animals are of little value as indicators of pollution, because they are found in both clean and polluted waters. Snails, black-fly larvae, water boatmen, and similar forms have a wide range and therefore are not good guides to water condition, except to the scientist who can distinguish the different species.

Indicators of pollution may be summed up thus:

Water molds and scums, particularly if of colors other than green, indicate decreasing oxygen—conditions are not favorable and may be worse downstream.

Tubifex (a small, slender, red earthworm) marks approximately the limit of fish life.

Rat-tail maggots, if abundant over the whole bed of the stream, are almost certain indication of prohibitive pollution.

Bloodworms indicate recovery and conversion of wastes into fish food.

Green plants, mosses, usually indicate good or improving conditions.

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